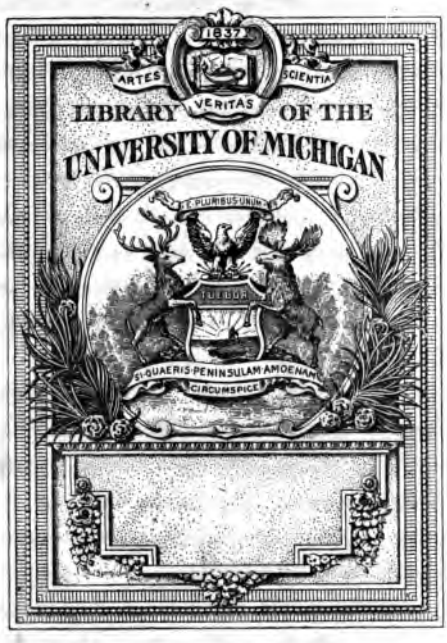
Hamilton, Observations and sections made in the district lying between the Dublin and Mourne mountains.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OBSERVATIONS AND SECTIONS

MADE IN

THE DISTRICT

LYING BETWEEN THE

DUBLIN AND MOURNE MOUNTAINS.

BY

C. W. HAMILTON, Esq., F.G.S. M.R.I.A.

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M.DCCC.XXXIX.

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OBSERVATIONS AND SECTIONS,

&c. &c.

My original undertaking was to have made for this Society a section from Slieve Gullion to Kippure, with a view of clearing up the obscurity which appeared to me to hang over the relations between the granite of the Dublin and Mourne mountains, the slate which rests against it, and the limestone which overlies the slate occupying vallies in the neighbourhood of Dublin, Drogheda, and Dundalk. I found more difficulty in this task than I had anticipated, and that indeed it would be impossible to make one line of section accurately in the proposed direction, I was therefore obliged to make many minor sections in distant parts of the country, and the extent that I found it necessary to traverse, and the little leisure I had for working in so distant a locality, would have deterred me from making any communication to you upon the subject, if it were not for the conviction that it is the duty of every member to bring in to this Society the result of his summer's field work, and the feeling that where the observations I have made differ from those of Mr. Weaver, to whom we are indebted for the only description of this district which has hitherto appeared, it is of importance to myself to have them tested by being brought under discussion before the Society.

Note.—The specimens exhibited with this paper are in the Museum of the Society, with labels indicating the localities.

I shall now attempt to give you a general idea of the character of the country, and of the impressions which have been made upon me in the examination of it, reserving the details for a subsequent communication.

The northern portion of the district is that comprised between the parallels of Newry and Dundalk, embracing the Carlingford mountains, Slieve Gullion, and the range of minor hills running from Jonesborough to Forkhill. The highest mountains are composed of granitic compounds of felspar, quartz, and hornblende, with a little mica occasionally appearing, but scarcely constituting a characteristic of the rock; the quartz and felspar are nearly white, and the rock varies in colour from a light grey to black, according to the proportion of hornblende which it contains; there is almost every shade of mineralogical distinction through which it appears to pass, on the one hand into the greenstones of undoubted dikes, and on the other into the slates which as indisputably lie stratified on the lower declivities of the mountains.

Slieve Gullion rises the height of 1893 feet above the sea, out of a plain which extends around it, for an average of about two miles to the foot of the surrounding barriers of Jonesborough, the Forkhill range, and the Fews mountains; this plain is covered and level, with the exception of several well defined ridges, which traverse it from Slieve Gullion in a south easterly direction, until they are lost in the limestone district of Dundalk.

The summit of Gullion is a fine mixture of minute crystals of quartz, with very little felspar, and enough of hornblende to give it a light grey tinge of colour; the same rock is found at Feoghill Etra and Feoghill Otra to the east of Jonesborough; here it is very fine, and bears the appearance of stratification; at a quarry close to Meigh, near the south eastern foot of Slieve Gullion, it is found so fine as to appear almost a clear silicious schist, lying in beds, with a direction *20° north of east, and* divided into prisms by joints which

are filled with a coarser granite containing some mica; a close examination, however, shews that this fine rock, the granite, and veins of a distinct greenstone, which lie irregularly parallel to the joints, pass gradually into each other, and leads one to suspect that these coarser beds may be only instances of a variety in the mode of crystallization connected with the fissures of original jointage. At the western foot of Slieve Gullion there is a valley which runs in a curve round that side of the mountain from north to south; it consists of a rock differing from that of Slieve Gullion (which bounds it on each side of the valley and traverses it in veins) only in the great preponderance of hornblende, which is however vary variable; this rock is sometimes prismatic; the end of the valley corresponds with the end of the principal of those ridges which I have alluded to as crossing the plain.

A granite compound, coarser than that of Slieve Gullion, and containing a large proportion of yellowish opake felspar, constitutes the hills in the immediate neighbourhood of Newry; the ridge which runs south and parallel to the Newry river ends nearly opposite Warren Point, and trends round by Clermont Carn to Annaverna mountain; it forms also the greater part of Feede mountain, and occurs at the northern foot of Carrickbroad, one of the Forkhill range. From Carneen a Waddy, along the high ridge of Carlingford mountains, we find nothing but a syenitic compound of greenish translucent felspar and hornblende; the felspar is semi-crystalline, and bears a proportion of about two to one to the hornblende; it is very coarse-grained, and epidote occurs in abundance, although not distributed evenly enough to be considered as a necessary constituent of the rock; the Trumpet Mountain is a very coarse-grained syenite, differing from that last described in the size of the crystals of hornblende, and in the felspar being purely white and more opake, but still translucent at the edges; in it I did not find epidote. I shall now give some sections explana-

tory of the connexion between these granites and their overlying rocks.

At about half mile south of Newry, in the old road which runs along the Fathom Hills, we find a greenstone slate, direction E. and W.; this is succeeded to the south by a talcose slate, similar to that which may be seen at Wicklow Head, on the sides of Brandon Mountain in the county of Kilkenny, and other places where slates are found in the vicinity of granite; this covers about a quarter of a mile of surface, but as the dip is not clear, the actual thickness has not been ascertained; as it approaches the granite, but where the rock still is evidently stratified, a remarkable change takes place, it is very fine-grained, but a minute examination shews, that the quartz and felspar are distinct, and scales of mica are mingled with the slate; this is immediately succeeded by the granite of the Fathom Hills. On the southern side of the Fathom Hills, at a turn of the Hill S. W. of Warren Point, we find slates lying immediately upon the granite, with an E. and W. direction: they are porphyritic, containing large imperfect crystals of vitreous felspar, in a fine-grained dark-green base. Slates are found abounding in similar concretions or crystals of felspar, chalcedony, and calcareous spar in various localities, associated with greenstone, and not remote from granite; among others I may particularize, Portrane, Lambay, and Dunganstown, in the county of Wicklow, districts in which the metamorphic slates appear to bear the strictest analogy to those under our present consideration. The valley running again to the N. W. from this point up nearly to the watershed line between the Bracket Mountain and Clermont Carn, the neck between Clermont Carn and Carneen a Waddy, and the valley along the watercourse descending from thence to Anaverna, consists of hard felspathic slates, striped green and black, with a direction 30° N. of E. and perpendicular dip; they are exactly similar in character to those which lie against the Mourne Mountain, between Newcastle and Kilkeel; the probability is, that

they are doubled up between the two mountains, and where they are found on the slope of the hills, the dip is adapted to their contours. There is a very remarkable junction between the hard slate and the syenite; about half way up the mountain, immediately over the town of Carlingford, the actual point of junction is scoriaceous, but at this place, the syenite appears as if regularly stratified in beds, conformable to the overlying slate.

In tracing the junction along the southern slope of the Carlingford ridge, at a river course running south from Ballinteskin, there is a good opportunity of observing the connexion between the syenite and slates. In a descending series, we find a white compact felspar changing into dark red from the effect of weathering. A dark slate containing irregular masses of yellow felspar, which gives those parts of the rock an appearance exactly similar to that of the granite compound of Clermont Carn, a dark slate distinctly stratified and lying against the syenite, described as constituting the Carlingford ridge, this latter breaks through it in dikes. Fig. 1 is a sketch of one of the largest. I have called these stratified rocks slates, because to the naked eye they have that appearanee, but upon examining them with a lens of high power, it may be clearly seen that their constitution differs in no respect from that of the coarse-grained syenite of Carlingford mountains, except in the size of the component parts.

The section from the Trumpet Mountain along the watercourse running from Carneen a Waddy, is very instructive (Fig. 3.) I have before described the Trumpet as a coarse-grained syenite, consisting of a white felspar and hornblende. To the north of it is a synclinal in which the upper beds are hard slates, and in the lower, the structure becomes gradually more crystalline, and spots appear in the rock of a lighter colour, owing to the presence of masses of translucent greenish felspar. One of the lowest beds has exactly the character of the rock described as lying against the granite

on the east of Fathom Mountain. Between these greenstone slates, and the coarse syenite of Carneeh a Waddy, is interposed a rock very different from either, consisting of semi-crystalline felspar, very transparent, and of a rich brown colour, passing into wine yellow; it contains hornblende and quartz, but in very minute quantity; it weathers into an opake dingy yellow, and it is so subject to weathering, that it seldom presents its original character, and this circumstance distinguishes it strongly from the syenite upon which it reposes, and upon which the weather has scarcely any effect, except that of producing disintegration. We find it occupying the Ben rocks, Clermont Carn, and all the high ridge from Annaverna to Jonesborough; in descending from the Ben Rocks to Ravensdale Bridge, we meet with the same succession of slates, consisting of a dark coloured base, apparently containing hornblende with crystals of vitreous felspar; first coarse, and then finer in grain, until the transition into the hard slate is perfect.

Before describing the rocks to the west of the road from Dundalk to Newry, I may allude to the analogy which exists between those already mentioned, and those which are found in the Mourne mountains: a reference to Mr. Griffith's Map will shew a number of immense dikes, 200 or 300 feet in width, proceeding to the east from Slieve Donard, and other mountains forming the chain that extends from Newcastle to Kilkeel. I had only time to examine one of these, and that the nearest to Newcastle. Slieve Donard is composed of a granite, about nine-tenths of which may be white felspar, through which are interspersed crystals of hornblende, mica, and quartz, in variable proportions; quartz is the least characteristic mineral, the grain is fine, and it is only in fissures and veins that the large crystalline specimens of felspar, quartz, beryl, and topaz, which adorn mineralogical collections, are found. These mountains are surrounded by slates, which Lieut. James, R. E., correctly described to your Society as abutting against the granite hills, and which

at Newcastle have a direction of 40° east of north, to the first dike 41° east of north), which are exactly similar to those described as standing on the ridge between Clermont Carn and Carneen a Waddy—hard, felspathic, and striped light and dark coloured. In pursuing these slates along the coast to about a quarter of a mile south of Bloodybridge, we find their course interrupted by a rock, the relations of which to the slate I cannot clearly see; we first find a chasm of about ten feet wide, of great depth, and running 28° south of east, the north wall of it consists of the section of the slates at right angles to their direction; the southern wall of a white compound of quartz and felspar, the quartz predominating; it contains a trifling proportion of minute crystals, apparently of hornblende and epidote; it lies in bells against the mountain, and these beds are contorted on one place I saw patches of slate lying conformably upon the outermost beds. About 150 yards from the beginning of this porphyritic rock there is another chasm running parallel to the first, the southern wall is represented in Fig. 4; *b* is the quartzose felspathic rock, which at *c* is rudely columnar; *d* are masses of slate exactly similar to that outside the dike, retaining their cleavage; one of them is fifteen feet long by six feet high, the porphyry itself has a distinct cleavage nearly perpendicular and at right angles to the principal joints. Twenty or thirty yards further to the south we find a dike of compact felspar of a light grey colour, it contains crystals of quartz thinly scattered through a base, which has probably less alkali than is usual in the mineral called compact felspar, as it is fusible before the blow-pipe only in minute scales and with great difficulty; this dike traverses the beds of felspathic quartzose rock, and throws them in opposite directions, as shewn in Fig. 5. A little further on this fine rock is so blended with the coarse variety that we are obliged to conclude them to be of contemporaneous origin. About thirty yards further the slates occur again, with a direction 40° north of east, and dip to the

south; here the felspathic quartzose rock is seen lying upon them unconformably as in Fig. 6, and this is the varied appearance of that which has been hitherto described as a porphyritic dike.

I now return to the chain of hills running on the west of the Dublin road from Jonesborough to Forkhill: next immediately over Jonesborough is a black fine-grained rock, with what appears to me a decidedly arenaceous character; but it contains also little patches of greenish felspar and nodules of quartz. I could find no abrupt parting between this and the light-coloured and very purely crystalline mixtures of quartz, felspar, and hornblende, which compose Feoghill Etra and Feoghill Otra; in crossing over to Feede Mountain I found a rock resembling that of the Clermont Cara, and Feede Mountain itself is a long ridge of yellow felspar, quartz, and hornblende, rather coarse-grained, and in which the felspar greatly predominates; on the southern declivity of this hill I found alternate beds of a dark compact trap, *a a*, and this granitic compound, *b b*, interstratified and dipping into the hill, as shewn in Fig. 7; the dark beds are a very fine mixture of white translucent felspar and black grains, which I conclude to be hornblende, though they are too minute to admit of being determined with certainty; the constituents of the two rocks are nearly the same, except that in the coarse-grained variety the felspar is more opake and yellow; if one must be considered as an intruded rock, I think analogies which I shall subsequently point out give the balance of probability to the coarse-grained; but although at this particular point they appear distinct, yet in others they pass so much into each other, and into the slates which are found at the base of the hill, that I cannot consider them in any other light than as of cotemporaneous if not identical origin; from Feede to Forkhill the rugged heights are composed of a porphyry, which evidently rests upon the micaceous granite found at their northern bases; it consists of a compact quartzo-felspathic base, very similar to that described as

forming the finer parts of the dike near Newcastle; it is variable in colour from dark to light grey, through it we discriminate small crystals of transparent felspar and quartz; it is identical in appearance with the porphyries of Caernarvonshire, and answers Mr. De La Beche's description of the Cornish elvans; it is a conglomerate, and contains rolled pebbles of a greenish slate; in some places, as at Carrickmaffrin, south of Forkhill, it is regularly divided by joints perpendicular to each other into prisms of about one foot square; in most it has some appearance of stratification, or at least of lying in beds. In the river which turns Balriggan mills, at about one mile and a half south of these hills, we find a red sandstone conglomerate, which directly underlies the limestone, and rests unconformably upon the green hard slates, which intervene between the limestone and Forkhill range; it consists of grains of white transparent felspar and quartz, with ferruginous matter and rolled pebbles of greenish slate. I think that an inspection of the specimens of these sandstones and the porphyries of the Forkhill range will leave no doubt upon the mind of any one, that this latter is merely a modified condition of the former.

The slates in the immediate neighbourhood of the porphyry, as may be seen in the south of Carrickmaffrin, are very different from those which underlie the sandstone; they are hard, compact, and broken into angular fragments, so as to assume the appearance of an omogeneous breccia. Between these slates and the porphyry we find in many places along the junction a remarkable conglomerate which consists of a base of apparently the detritus of slate rocks containing large irregular fragments of granite; hand specimens may be found containing the granite, porphyry, and slate in such intimate union, that it is hard to say whether the granite structure was original or superinduced upon particular pebbles or parts of the conglomerate. In the centre of Carrickbroad and at the very summit we find two irregular eminences which are recognized at a great distance as the features of that

range, and are known by the name of Diacle a worre. Here we have a curious mixture of the brecciated slate and the granitic conglomerate, twisted and woven together. In a country which is evidently so much disturbed, and among rocks in which the traces of stratification are so nearly obliterated, observations upon the dip and strike are not much to be depended upon, but I may allude to the fact, that the slates appear to have a general direction included between 5° and 15° N. of E. and the sandstone at Balriggan Mill and the porphyries are included between 10° and 35° E. of N. The section in a ravine through which the old road to Jonesborough runs, is given in Fig. 8, embracing an extent of about 150 yards. *a*, Fig. 4, is a slate hanging to the S. of which the upper part is distinctly in thin beds, and has a granular appearance; at *b* the structure becomes crystalline and globular, minute nests of hornblende are distinctly visible, and larger crystals of white felspar; at *c* the porphyry has the character of that constituting the range of hills; and at *d* it consists of flat thin plates of opake greenish felspar, sometimes half an inch broad in a base of semi-crystalline hornblende.

Having thus described the most striking characters of the rocks which in this district occupy broad spaces, I shall proceed to notice very briefly the dikes which traverse them. On the road from Newry to Dundalk, on the top of the hill about one-quarter of a mile from Newry, a very remarkable dike may be seen traversing the granite; it is about twelve feet wide, carries large masses of granite along with it, and the flat rhomboidal prisms into which it is divided arrange themselves perpendicularly to the masses of granite, whether included boulders or walls: at this point it appears to run to 30° E. of S.; the same dike may be seen to the N. of the road. Further on there is another dike with the same direction, but not above fourteen inches wide; these appear to be a fine-grained mixture of white felspar and hornblende; the dikes which intersect the lime quarries at

Carlingford are similarly composed. In a district so full of these dikes it is unnecessary to describe more than a few instances; but the fact which struck me most forcibly was, that the prevalent direction is to the S. of E. or rather the E. of S. and the thinning out of the dikes in that direction proves that they must have flowed from the N. W. Every lime quarry in the neighbourhood of Dundalk is traversed by these dikes; in some places, we find them in beds of equal thickness, lying between beds of limestone, so that they might pass for interstratified deposits, but where the quarry is sufficiently open the termination of the sill appears as in Fig. 9, or other forms equally indicative of obtrusion. In some quarries, as that to the west of Bellurgan, the trap has burst out in greater masses, the strata of limestone are tossed in every direction, and the limestone itself, in connexion with the trap, becomes granular and semi-crystalline.

Fig. 10 represents a curious development of trap seen in the cliffs which overhang the northern edge of the river; about a quarter of a mile above Balriggan mill the limestone, which is unaltered and very encrinal, appears on each side of this dike, which extends about fifty or sixty yards, to dip in under the trap; some beds of strata in immediate connexion with the dike are indurated, the dike itself is composed of large upright angular prisms, which present salient angles to the observer; the faces of these prisms are composed of smaller prisms, arranged with their ends outwards, giving them the appearance of brickwork, but the most remarkable circumstance in this dike is, that on examination with a lens it appears to be granular, and not distinguishable from the sandstone described as filling the bed of the river at the mill; except in its jointed structure and fineness of its components, it is quite different from the highly crystalline greenstones before described. I shall only refer to one more dike, which is represented in Fig. 11, and embraces a portion of about fifty yards of the side of the road from *Roche's Castle* to Forkhill; it is of the fine-grained syenitic

character, and traverses slates in the manner represented; the slates which are nearest to it are highly calcareous, and appear as if the effect of the trap was to make them give out the calcareous matter which crystallizes in all the joints; many of the joints are polished as slickensides; at a distance from the trap calcareous bands are rare.

I shall reserve the slates and limestones to the south of Dundalk for a second part of this paper, and only observe, that in Lambay, on the Portrane shore, and the east of the County of Wicklow, the same irregular graduation of the original arenaceous rocks into porphyries, containing crystals, and concretions of felspar and quartz, until they pass into crystalline greenstones or compact quartz, is distinctly traceable. Another observation, to which I attach some importance, I may allude to, as it will assist us in reasoning upon the facts already described, although I shall reserve the details and proofs for another evening; it is that the positive thickness of the slate formation has been generally over-estimated. Cleavage and diagonal lamination have been frequently recorded as planes of stratification, and as an instance of the mode in which the same beds follow the irregularity of the contour of the country, I may mention the result of very careful observations, which convince me that the stratification of the altered slates which compose the island of Lambay might be familiarly illustrated through the means of a model representing the irregularities of its shape, with a many folded wet cloth thrown over it as a nucleus. Mr. Griffith has also expressed a wish that I should attach to this part of my paper the general result of my observation on the boundary of the calp district; this I can do in a few words. In the Queen's county I have made sections of the chain of hills which are represented in the railway map as running from near Stradbally to Timohoe, and from Killone Hill near Bally Brittas towards Abbeyleix. These hills give very clear *good sections of* between 500 and 600 feet of limestone lying

immediately below the Kilkenny coal field; it agrees exactly with Mr. Griffith's description of the upper or splintery limestone; it contains subdivisions distinctly marked by their mineralogical character and the prevalence of particular fossils, and these distinctions I have found to be constant to similarly posited beds over the whole area that I have examined.

The same limestone occupies the area comprised between Lough Derevaragh, the slate hills in the neighbourhood of Oldcastle, and the chain of hills running from Loughcrew to Fore and the south eastern end of Lough Derevaragh in the counties of Meath and Westmeath, and constitute the hills which lie between Moate, Ballymore, and Kilbeggan, in the county of Westmeath; it rests upon the calp or black impure limestone and shales. I have given two sections, one in the Queen's county, (Fig. 13,) and the other in the county of Westmeath, (Fig. 12,) to shew the character of the stratification; that one from Loughsheelin to Carrick embraces an extent of about nine miles, it exhibits two lines of disturbance, which I have traced for some distance, and shall describe minutely on a future evening.

As there may be some of our members present who have not read the more recent works upon Geology, I think that before I proceed to draw those deductions which I believe to be warranted by the facts I have laid before you, it may be well to explain very briefly the opinions at present generally adopted respecting the class of rocks which I have been describing. The diagram which forms the frontispiece to Mr. Lyell's Elements of Geology, may be taken as a fair representation of the state of the science up to the past year; the distinction between stratified and unstratified works is there distinctly maintained, and the exterior of the earth's crust is described as constituted of successive layers of gradual deposits of materials held by water, either in solution or mechanical suspension. These regular

layers are supposed to have been at different periods and under different circumstances disturbed and broken through by currents of lava flowing in a strata of igneous fusion from the interior of our globe; it is supposed that these lavas, derived all from the same source, have in cooling assumed different characteristics, according to the circumstances under which the cooling process took place, and that the volcanic matter irrupted at great depths and under great pressure of matter, either fluid or solid, has assumed the appearance of granite and greenstone, while that which flows only under atmospheric pressure presents itself to our view under all the varieties of modern lava, scoriæ, &c. It may be bold to question the authority of the ablest and most philosophical of English geologists; but I must say that I think this diagram is calculated to convey an idea very different from those which he has put forward in the body of the work, into which he has woven the discoveries of Keilhau, Cotta, and other continental geologists. There is another point upon which it appears to me that not only this diagram, but the tables given in most elementary works, are calculated to convey to the learner erroneous impressions of the thickness of the rocks which have been seen by man. If we turn to Professor Phillips' last work, we find "a table or section of the series of strata which constitute the crust of the globe, *placed* in the order of their succession downwards from the surface of the most recent aqueous deposit." Now, in this table the thickness of the fossiliferous beds alone is estimated at above six miles. The grauwacke and clayslate systems developed in Wales, the North of England, and South of Ireland cannot be less than four miles, and the necessary conclusion from Mr. Lyell's diagram is, that from at least that depth the plutonic and volcanic rocks must have issued; but it is of importance to observe, that these formations have nowhere been seen all together, and if we consider that at any *former æra* the surface and occupation of the globe was

probably as varied as it is at present, and that the untroubled bottom of the ocean may have been the place of the finer arenaceous deposits, accumulated at a depth unfavourable to the existence of animal life, while the shores of that ocean were lashed by waves capable of wasting the rocks and producing rude conglomerates; and while embryo limestones were accumulating in the coral reefs and river deposits, forming extensive deltas. When we consider how distinct are the species of plants and shells, which would enter into the composition of recent marls formed in Sweden and South Africa, we may well doubt whether there has not been an overstatement, and whether many of those which have been laid down as successive, have not been in reality cotemporaneous formations. This last year has, however, produced two works which will tend to modify considerably the views supported by Mr. Lyell's Diagram, Keilhau's Gaea Norwegica, and Cotta's Geognostiche Wanderungen; and when I state to you that to every part which I have described I have found a parallel in Keilhau's accurate and full description of the rocks in the neighbourhood of Christiania, I may mention that my observations were made before his work was published, as it shews that mine were not made in support of a theory, but forced upon me in opposition to the opinions which I had already imbibed.

The most striking parts in Keilhau's work are the proofs he brings of having found:

1. Hard slates passing into hornstone and crystalline limestone, as a continuation of the same beds, which at no great distance appear as soft clay slates and ordinary lime stone.

2. That in rocks so altered the divisional planes of stratification disappear, but the joints become more distinct.

3. That those slates which when unaltered are simple alum slates, are altered into chiastolite slate.

4. That the gradual transition may be traced in strati-

fied rocks from a soft slate into a granitic compound of quartz, felspar, and hornblende, which has been described by Von Buch as a fine granite; and that, in fact, the granitic and syenitic rocks which he describes can "*in no way be supposed to have flowed from the centre of the earth in a liquid condition*," but that the crystalline types are in unbroken continuity with the stratified rocks, and are no more than the last members in a series of progressive modification. All the transitions which he mentions, in describing the granite, are equally found in the greenstone and porphyry districts, and his final conclusion is, that where we now see extensive granitic districts, with their offsets and outlying masses, there existed formerly the same rocks which are found unaltered in other parts of the district, namely, that the beds which now form the granitic districts were formerly the same with those which occupy at present the slate and limestone districts; that these all consist of rocks, the induration of which must have taken place at a very early period, as they all have a considerable dip; and that they, at a time of which we can form no conjecture, with an object which is equally concealed from us, and by processes which time alone may reveal, without undergoing the least disturbances in the strata and dips of their beds, were changed, over greater or less areas, into crystalline silicates, into syenites and granites.

When we consider, also, the great change which has taken place, the power of the chemical agents which were at work, we shall not be surprised at finding that these altered rocks were at the point of contact with those overlying them enabled to penetrate and fill the crevices occasioned by the expansion of gases or mere mechanical violence, and so give rise to the appearance of dikes and veins.

In Cotta's description of the neighbourhood of Meissen, near Dresden, a district well known to tourists under the name of the Saxon Switzerland, I find every specimen which

I have laid before you every variety of porphyry, greenstone, and granite described as occurring in similar positions. So that the conclusions which he has adopted may be applied to our own country. The most important of them, and the only one to which I shall refer, concerns the granite of Weinböhla, which has long been supposed by geologists to be an instance of granite overflowing as a lava, the quadersandstein, a member of the greensand formation; his description, however, leaves us the option of concluding that the granite may have been an underlying bed reversed along with the greensand, and an oolitic bed which lies between them. If we go to the other side of the Atlantic, we find the metamorphic theory gaining strength, and founded upon facts exactly similar to those which I have described. I shall only refer to Professor Roger's Survey of the State of New Jersey, pp. 161 to 164. To return to our own country, we have seen proof of gradual change in the slates and conglomerates which I have attempted to describe, in which beds similarly stratified and equidistant from the overlying rocks first lose their soft character and become more compact and crystalline; in the different stages of crystallization separation takes place between the pure quartz and that compound of quartz and alumine, called felspar; small portions of lime and iron combine with quartz to form hornblendes and augites, and these simple substances are combined in endless variety until every form of granite, syenite, and greenstone is produced. When we have thus, in an unbroken chain, traced the stratified rocks downward from arenacious deposits to crystalline greenstone, we may, I think, soundly reason upwards, where we only meet the latter, even in dikes, and conclude that these also were originally of mechanical origin, and that the dikes which traverse all these rocks, even including the granite, owe their origin to the partial fusion of some rock which underlay that, from the alterations of which the granite has proceeded. If we turn to the geolo-

gical map, and take the carboniferous limestone as a standard from which to measure thicknesses we shall find, that a depth of above three miles is, in the south of Ireland, occupied by the cambrian slates, and conglomerates, while the same position is in the north and west taken by granites and syenites; and that the granite is unconformable to the slates which rest against it, does not necessarily involve a massive obtrusion, as the same unconformability is seen in the southern slates and conglomerates to those highly contorted slates which overlie the red sandstone of the Gaulty mountains, and occupy the country between them and the south of the county of Cork, a formation which I suspect to be identical with that occurring in the country between the Mourne and Dublin mountains. I have described the conglomerate structure of the porphyry of the county of Armagh, and the arenaceous character of a columnar dike. I do not find in Mr. De La Beche's account of the cornish elvans any reference to included boulders, but at page 177 we have the remarkable passage, "at the termination of a long dike extending about nine miles to the eastward of Penstruthall, where it cuts through the granite, even the porphyritic characters become lost, and the substance not unlike some arenaceous rocks; it is white and rather friable; a fine grained compound of quartz and felspar: a short distance west, however, the elvan is a well characterized porphyry."

The course of the dikes in the Slieve Gullian district is more or less approximate to a line from N. W. to S. E., so that they cross the prevailing strata of the country which is N. E. to S. W. It is particularly desirable that observers should mark the course which the dikes have taken, and which may be easily gathered from the point towards which it thins out and ceases. I mention this because I do not find that it has been sufficiently attended to. That the course of dikes should be at right angles, or nearly so, to the general axis of elevation in any country, is in exact accordance with

Mr. Darwin's observations upon facts in America, and Mr. Hopkin's *a priori* arguments. I shall now conclude with the hope, that, however imperfect may be the ideas I have attempted to convey to you, they may at least serve to excite attention to the successful labours of foreign geologists, and a zeal to make our own country a field for unravelling the mystery, as yet hanging over these, the most interesting of geological phenomena.

THE END.